



**BetterBuilt<sup>NW</sup>**



# Heat Pump Water Heater Technical Guide

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for Detached Single-Family New Construction and  
Additions Greater than 500 sq. ft.

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## Heat pump water heaters are a proven technology known to improve water-heating energy efficiency.

They are now more available, efficient and reliable than ever, with products carrying a 10-year warranty. As water heating accounts for roughly 18% of home energy use, this appliance can have a significant impact on lifetime energy use.

While installation of heat pump water heaters is similar to installing standard-tank water heaters, there are some important considerations detailed in this guide. These include considerations regarding condensate management and selecting the best location to enhance performance and customer satisfaction.

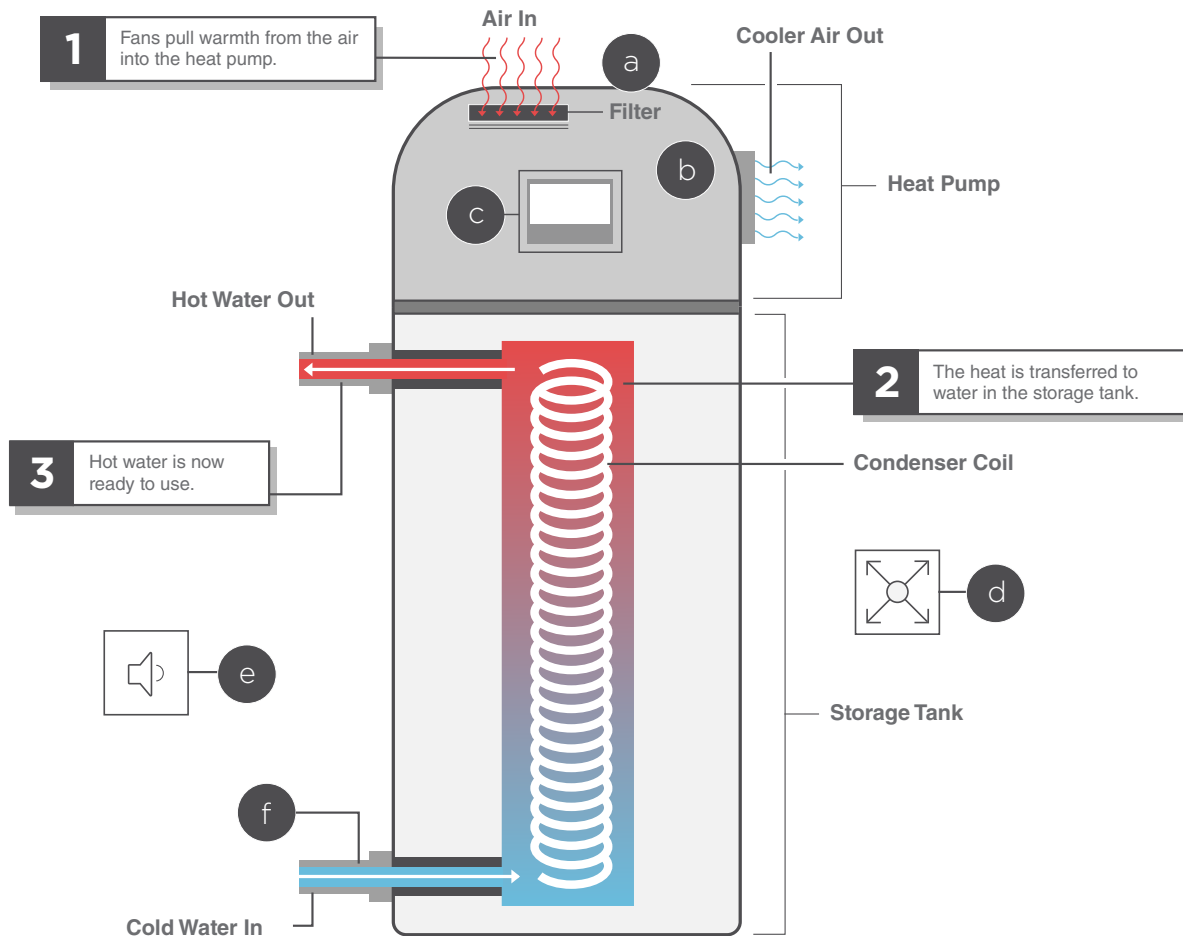
## HEAT PUMP WATER HEATER FEATURES AND BENEFITS

- Reduce energy consumption and operating costs by up to 60% compared to standard electric water heaters.
- Access a cost-effective path to Washington State code compliance by receiving 2 or more credits from Table R406.3—the most points available for any water heating option.<sup>1</sup>
- Follow the strategies and tips enclosed to utilize current house plans with little-to-no redesign needed.
- If you can install an electric-resistance water heater, you can install a heat pump water heater.
- Avoid the need for venting, combustion condensate management, or stands for garage installation.
- Achieve more hot water delivery capacity than standard electric resistance tanks.
- Easily set the temperature and change operational modes to maximize efficiency using the digital touchscreen control panel. This delivers much more flexibility than standard electric water heaters.
- Minimum 10-year manufacturer warranty on tank and parts.

<sup>1</sup>Split-system water heaters qualify for 2.5 credits. Refer to split-system water heater section on page 9 of this guide.

## HOW IT WORKS: THE ANATOMY OF A HEAT PUMP WATER HEATER

Standard water heaters require a significant amount of energy to heat water. In contrast, heat pump water heaters use less than half the energy to heat the same amount of water. By extracting heat from the surrounding air and transferring it to the water inside the tank, heat pump water heaters are able to reduce the amount of heat that must be created.



### ► Key Differences from Standard Water Heaters

- |   |   |
|---|---|
| <b>a.</b> Filter cleaning required, along with sufficient space above | <b>d.</b> May require a little more physical space and sufficient make-up air space |
| <b>b.</b> Cold exhaust air  | <b>e.</b> Modest amount of noise  |
| <b>c.</b> Digital control panel                                       | <b>f.</b> Side piping on most units   |

## Heat pump water heaters have several unique installation requirements in comparison to standard electric or gas water heaters.

The following includes system features, installation and operating tips and best practices by audience:

- Developers and Homebuilders \_\_\_\_\_ 5
- Architects and Mechanical Designers \_\_\_\_\_ 6
- Construction Teams and Plumbers \_\_\_\_\_ 7



## DEVELOPERS AND HOMEBUILDERS

### Connectivity and Controls

Heat pump water heaters can become part of your connected home with the following features and capabilities:

- Digital control interface
- Wi-Fi connectivity and smartphone app (availability varies by model) to remotely change temperatures, engage vacation mode, and monitor performance
- Leak detection (some models)
- Models equipped with a CTA-2045 port can participate in the smart grid to enable more renewable electricity generation

### Heat Pump Water Heater Key Benefits:

- Maintain current house plans with little-to-no redesign needed.
- Reduces water heating energy consumption and operating costs by up to 60% compared to standard electric water heaters.
- Delivers more hot water than standard electric resistance tanks.
- Offer your customers a minimum 10-year manufacturer warranty on tank and parts.

### Washington State Energy Code (WSEC) Energy Credits

A NEEA Tier 3 heat pump water heater offers a cost-effective path to 2018 WSEC compliance. Select Option 5.5 from the Energy Credits Table 406.3 to receive 2 credits.







# ARCHITECTS AND MECHANICAL DESIGNERS

## Space and Location

Manufacturers typically require access to 700 cubic ft. of air volume in the space where the water heater is installed, along with sufficient space to allow installation and service. For a house with 9-ft. ceilings, this translates to a 9x9 ft. room. Garages are ideal locations, providing ample space for heat pump water heaters. If your house is in a colder climate, such as those found east of the Cascades, consider possible freezing conditions in the garage and follow standard location practices in your area. Basements, utility rooms, and laundry rooms also offer excellent locations for the water heater. Be sure to consult the manufacturer’s installation guide for recommendations specific to your model. For further considerations, reference the FAQ section beginning on page 11.

## Cool Exhaust Air

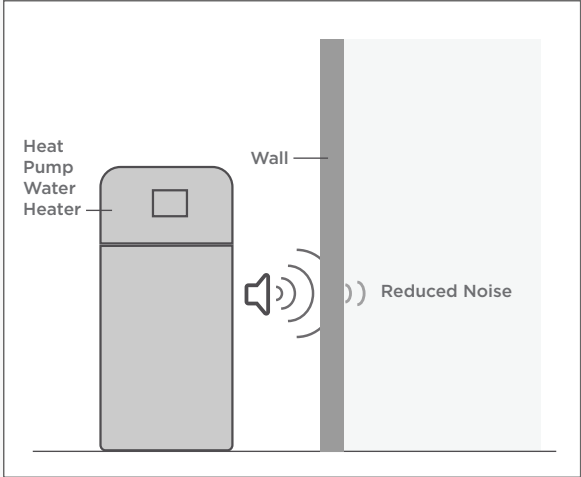
Heat pump water heaters exhaust cooler air than their surroundings. Therefore, they should not be located in rooms that are frequently occupied by temperature sensitive activities. When garages are not available, basements, utility, and laundry rooms also serve as excellent locations.

## Drain Water Heat Recovery

Drain water heater recovery (DWHR) is an effective way to reduce the energy use of the water heater, increase useful stored hot water capacity, and receive another 0.5 credit from 2018 WSEC Table 406.3 (using option 5.1). Futher, DWHR is a natural pairing with heat pump water heaters and any number of DWHR plumbing layouts will complement the heat pump water heater.

## Sound

Heat pump water heaters have a fan and compressor, both of which make noise. Tier-3 heat pump water heaters emit sound at levels less than 55 dBA. Standing on the other side of a wall or door, the sound level drops to 35–40 dBA, which is quieter than a refrigerator. Still, placing the water heater away from bedrooms and living rooms can help mitigate any potential sound issue. Check with manufacturers for best practices regarding isolation pads, foam, and mounting strategies.



## Tank Size

First, follow the local plumbing code. For maximum efficiency, upsize the tank over your standard practice. Heat pump water heaters typically come with auxiliary resistance elements that can run to meet periods of high water demand. This operation is far less efficient than running the heat pump alone. Upsizing the tank will minimize inefficient resistance heating, allowing the heat pump to do most of the water-heating work. The Uniform Plumbing Code requires a minimum First Hour Rating. Meeting that minimum and then increasing the tank size as indicating in the following table will reduce energy use.

Tank Size Guidelines

Number of Bathrooms	1 to 1.5			2 to 2.5				3 to 3.5			
	1	2	3	2	3	4	5	3	4	5	6
Uniform Plumbing Code Minimum First Hour Rating (gallons)	38	49	49	49	62	62	74	62	74	74	74
Minimum Typical HPWH Tank Size (gallons)	40	40	40	40	50	50	65	50	65	65	65
Up-Sized Tank (gallons)	50	50	50	50	65	65	80	65	80	80	80



# CONSTRUCTION TEAMS AND PLUMBERS

Installing a heat pump water heater is essentially the same as installing an electric resistance water heater, so no additional trades are needed on site. Installation is simple, with no refrigerant handling required. In addition to following the guidance of product manuals, consider the following best practices:

## Clearance and Positioning

- Follow manufacturer specifications regarding water heater clearance and seismic strapping.
- Position the unit so the control panel is facing outward and easily accessible to the homeowner. Make sure all data connection ports are accessible.
- Aim the exhaust air away from the center of the room so it does not inadvertently blow on anyone walking past. Also direct exhaust away from any thermostats, if present.
- Ensure the intake air path is sufficiently free and open.
- Make sure that the positioning allows for easy access to inspect the water heater and controls, change the air filter, and drain the tank.

## Condensate

Heat pump water heaters produce a benign condensate that must be drained away from the water heater. Unlike condensing gas water heaters, which produce acidic condensate as a combustion byproduct, there are no special piping or handling requirements for heat pump water heaters other than to convey the benign condensate to a drain.

Ensure the water heater is level so condensate properly collects into, and drains from, the condensate collection pan. Non-level installation can lead to uncontrolled condensate overflow.

## Condensate Pipe Routing Tips by Water Heater Location

### Above Grade (e.g., garage)

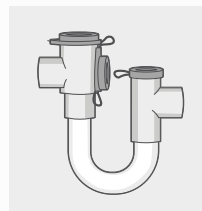
- Install to ensure drain line won't freeze (consult installation manual for best practices)
- Laundry and/or sink drain

### Below Grade (e.g., basement)

- Pump to outside
- Drain to floor drain, laundry sink and/or p-trap to plumbing line

### ► Condensate Tip #1

For added utility, consider draining the condensate outside to irrigate the landscape. For additional benefit to the homeowner, install the condensate drain with a p-trap and a tee port opening so the homeowner can periodically flush the condensate line with vinegar or similar cleaning solution. Note: P-traps should be installed in conditioned spaces only.



### ► Condensate Tip #2

Condensate pumps, commonly paired with air conditioners, can be used to drain the condensate produced by a heat pump water heater. A single pump may often be used for both the air conditioner and the heat pump water heater.



## Insulation Pad

Provide minimum R-10 foam pad under the heat pump water heater to minimize unnecessary heat loss through the bottom of water heater. (Note: this is required by Washington state code R403.5.5 for all unconditioned spaces or installations on concrete floors). This is a best practice regardless of floor type, and R-10 foam pads are readily available at plumbing supply centers.

## Seismic Strapping

As with other water heaters, your local code may require seismic strapping. When installing, use rubber standoffs when attaching straps to the wall to minimize the vibration and transfer of sound to rest of house.



## Drain Pan

If installing on a floor susceptible to water damage, install a drain pan to guard against any problems from future leaks. Connect the outlet from the pan to suitable drainage in accordance with your local code.

## No Stand Needed

Electric storage water heaters, including heat pump water heaters, do not need to be raised off the floor with a stand. That was a safety provision for older atmospheric gas storage water heaters located in garages. Most electric heat pump water heaters are taller than electric storage water heaters—they have the same nominal volume, but their connections are in different places. Make sure there is space above and around the heater to accommodate the variations for the models you are considering.

## Pipe Insulation

Insulate the hot water piping to at least the minimum requirements in IECC R403.5.3, or in accordance with your local codes—whichever is greater. To improve the system performance overall, insulate all of the hot water piping. It is more important to make sure the pipe insulation is continuous than it is to increase the wall thickness or R-value of the pipe insulation.





## Heated Water Circulation (Temperature Maintenance)

Do not use a continuously operated circulation pump (this is prohibited under energy code section R403.5.1.1). If pipe runs to fixtures are too long, use a demand, sensor, or occupant-activated pump to circulate just enough water to prime the loop with hot water. Connect the return pipe of the circulation loop to the cold inlet of the water heater—this will guide the cooler returning water to pool at the bottom of the tank so it does not interfere with hot water availability. Continuous circulation is particularly detrimental to heat pump water heaters, and will result in lack of hot water availability and greatly increase energy use. Consequently, never set the circulation system controls to continuous, and advise the homeowner of this requirement.

## After Installation: Servicing the Water Heater

NEEA Tier 3 heat pump water heaters come with a 10-year equipment warranty. After installation, heat pump water heaters require modest servicing. The air filter should be cleaned every 3–6 months, with a more frequent cleaning cadence in high dust locations. The heat pumps in current water heaters are designed like refrigerators to operate as a fully sealed system with no servicing, so there are no ports to add or remove refrigerant. On extremely rare occasions, the homeowner may have to clear the condensate drain port should it become blocked. Like any other water heater, follow the manufacturer's recommended service requirements including regular maintenance for draining the tank and servicing the anode rod.

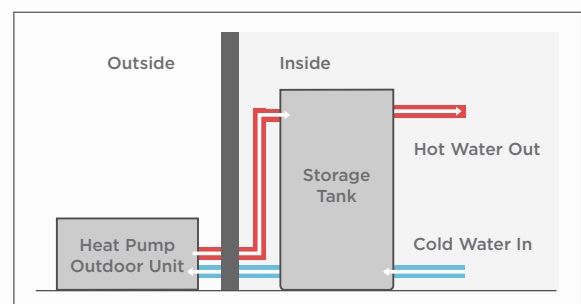


## SPLIT-SYSTEM HEAT PUMP WATER HEATERS

Split systems are heat pump water heaters in two parts, with the air-to-refrigerant heat exchanger designed to be located outside. With the heat pump outside, and the tank inside or in a garage, the two components are then connected with piping.

Split systems are useful in a number of design scenarios by offering several advantages, including:

- **2.5 credits from 2018 WSEC Table 406.3.**
- Some split systems currently on the market use carbon dioxide as a refrigerant which has an insignificant global warming potential (GWP) compared to conventional refrigerants like R-134a.
- The tank can be located in a confined space without access to airflow or a heat source. *(Examples of confined or challenging spaces include closets, under stairs, bedrooms, bathrooms, and cabinets under countertops.)*
- No cool air is created inside the house.
- The heat pump is outside the house, reducing indoor noise.



# CODE/INSPECTION CHECKLISTS

Based on the requirements and best practices outlined above, the following checklists provide guidance on verifying the proper installation:

## Code Officials/Inspectors, verify:

- ☐ Condensate safely conveyed to drain or exterior. (*Note: condensate is benign water requiring no special pipe material.*)
- ☐ Proper wire gauge is used. (*Note: Most heat pump water heaters still have full-size resistance elements, so wiring requirements are identical to standard electric-resistance water heaters.*)
- ☐ T&P valve is properly plumbed.
- ☐ Wiring is grounded with proper gauge.
- ☐ Water heater is on minimum R-10 foam pad if in unconditioned space or on concrete floor.
- ☐ Seismic strapping is employed, as required by local jurisdiction.
- ☐ Pipe insulation is minimum R-3 or local code—whichever is greater.
- ☐ Correct spacing is provided around the heat pump (per manufacturer's instructions).
- ☐ Heated water circulation systems, if present, are configured to pump only on demand for hot water within the occupancy.
- ☐ The system is a NEEA Tier 3 or higher product.

## HERS Raters/Home Energy Inspectors, verify:

- ☐ Water heater is positioned with clear intake air path, and oriented to minimize exhaust air drafts.
- ☐ Water heater is positioned for easy access to the control panel and to change or service the filter.
- ☐ Connections to the water heater are located so that the water heater can be easily removed for repair or replacement.
- ☐ The system is a NEEA Tier 3 or higher product.
- ☐ Pipes are insulated.
- ☐ Make-up air volume around the water heater is large enough, or make-up air is provided as per the manufacturer's requirements.
- ☐ Recirculation loop (if present) returns pipe to cold inlet of water heater.
- ☐ Mode of operation is at a minimum of hybrid, and preferably heat-pump only.

## FREQUENTLY ASKED QUESTIONS

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### **Where do I put the water heater if the home does not have a garage, or if I am concerned about pipes freezing in the garage?**

Basements, utility rooms, and laundries are great locations for a heat pump water heater. Pick a spot that will not be frequented by occupants, and position it away from bedrooms and living spaces to fully mitigate any noise concerns. Heat pump water heaters mildly dehumidify the air around them, so they can be a helpful addition to a root cellar or pantry design.

### **How big does the space need to be?**

The key to successful heat pump water heater operation is to provide enough warm air for the water heater. You can locate the water heater in a small space as long as there is adequate airflow. This can be achieved by installing a louvered door (including 18 square inches for inlet and outlet (one high and one low) and grills and/or grates) or similar air gaps. In other cases, it may also be possible to duct the intake or exhaust air from or to another location in the house. Be sure to duct the cooler exhaust air to an adjoining space or duct the intake air from a neighboring room, and let the cooler air pool in the water heater closet. For safety reasons, never duct to or from the garage.

### **The heat pump water heater exhaust air is cool—should I duct it to outside?**

No. Although the exhaust air is typically cooler than the room air, it is usually far warmer than the air outside the house in Washington. Ducting the exhaust air outside will actually increase the energy use of the house.

### **When should we increase the size of the tank?**

Go from 50 up to 65 or from 65 up to 80 if you are worried about having enough water for the occupants. It is recommended to go up one size on the water heater if you know the use will be larger than typical, or if there will be more people living in the house than you originally sized for.

### **Can I use the heat pump water heater to back up my solar thermal water heating system?**

Heat pump water heaters can be used in conjunction with solar thermal. An even more effective approach is to use solar PV and run the heat pump water heater off the solar PV's electricity, with excess power delivered to the grid. Refer to manufacturer's recommendations for installation methods.

### **How do different NEEA Tiers work and why should I care?**

The Northwest Energy Efficiency Alliance (NEEA) has created a specification and test procedures that are suited both for cool and warm climates. The Advanced Water Heating Specification (**AWHS**) is paired with a Qualified Products List (**QPL**). The different tier levels range from 1-5 (1 being the lowest performing, and 5 being the highest performing). Higher tiers mean better performance, quieter operation, less dependency on electric resistance, and more integration to the utility grid. Considerations in choosing a specific tier may include locational challenges, attaining HERS points, and/or energy credits required in the residential Washington State Energy Code.

### **Can I duct air to the water heater from the outside and exhaust it to the outside (a.k.a., dual ducting)?**

Yes, however, be aware that anytime the outside air is below approximately 40F, the heat pump will not run and inefficient resistance heat will be used. Studies show pairing the heat pump water heater with a highly efficient heating system yields similar energy performance to dual ducting.

## **What heating and cooling systems should I use with my heat pump water heater?**

Any high-efficiency heating system pairs well with a heat pump water heater. Selecting heating systems with maximum credits from section 3 in the Energy Credits table (406.3) will provide maximum energy savings.

## **Will the heat pump water heater reduce the temperature of the room it's located in?**

Heat pump water heaters work efficiently by extracting heat from the surrounding air and transferring it to the water inside the tank. In an opposite manner, refrigerators work by extracting heat from inside the refrigerator and transferring it to the kitchen. Just as refrigerators do not make the kitchen noticeably warmer, heat pump water heaters do not typically make the room in which they're located noticeably colder.

## **If installed inside the house, will the heat pump water heater's energy savings be offset by the extra heating system runtime?**

Installed inside the house, the heat pump water heater will use some energy provided by the heating system in the winter and reduce some of the cooling system in the summer. Further, the heat pump water heater can make use of excess heat in the house from solar sources, other appliances, and even the ground. The more efficient the space-heating system is, the better the benefit for the heat pump water heater and the smaller the heating offset. Regardless of space-heating system, the energy savings from the heat pump water heater far exceed any additional energy needed from the heating system.

## **Are heat pump water heaters loud?**

Heat pump water heaters have a fan and compressor—both of which make noise. Tier-3 heat pump water heaters emit sound at levels less than 55 dBA, which is quieter than a typical conversation. On the other side of a wall or door, this drops to 35–40 dBA, which is quieter than a refrigerator.

## **Can I reduce the sound?**

To mitigate heat pump water heater sound levels, locate the unit far away from the most actively occupied areas of the house. Additionally, use vibration dampening standoffs to connect the seismic strapping from the water heater to the wall. Placing the water heater on an insulating pad will also help. Attaching a short duct run, such as a 90-degree elbow, can reduce sound. Finally, insulating the walls between the installation location and occupied spaces of the house can reduce sound levels.

## **How reliable are heat pump water heaters?**

Heat pump water heaters have been available for more than 40 years. Current heat pump water heaters are designed like refrigerators to operate as a fully sealed system with no servicing required. The only additional, regular service needed is to check the air filter every 3 months. Further, Tier-3 heat pump water heaters come with a category-leading 10-year warranty.

## **Will the occupants have enough hot water?**

Heat pump water heaters have hot water delivery capability that is comparable to or greater than electric-resistance tanks. Follow the tank-sizing guidelines on page 6 if you are new to specifying heat pump water heaters.

## **When should I go to a bigger tank?**

If space, budget and location allow, a larger tank is the better choice as they rely on the heat pump for the majority of, if not all, the water heating.

## **What if I need more hot water but can't install a larger tank?**

One approach is to install a tempering valve, which allows a higher set point on the water heater. Higher temperatures may result in small performance penalties. Always consult with local plumbing codes to guide professional installation and fail-safe equipment.



## **I have a 600 sq. ft. ADU and I need a heat pump water heater to get the energy credits. Where do I locate the heat pump water heater, and what other installation considerations are there for installing in a small space?**

If you are installing a heat pump water heater in a small space, consider installing it in an area that will not be impacted by a modest amount of noise and or cool air while operating (e.g., a kitchen closet with louvered door). Other installation locations to consider may include:

- closet with venting in and out of the structure
- sufficiently large crawl space
- adjacent semi-conditioned garage with enough volume of air (700 cubic feet)
- conditioned space outside that doesn't freeze (in this case, the unit will need to be set in Hybrid mode (heat pump water heater and electrical resistance))

## **Where can I find additional information?**

- General information: **[hotwatersolutionsnw.org](http://hotwatersolutionsnw.org)**
- List of Qualified Products: **[neea.org/img/documents/qualified-products-list.pdf](http://neea.org/img/documents/qualified-products-list.pdf)**
- Installation help: **[hotwatersolutionsnw.org/installation/do-it-yourself](http://hotwatersolutionsnw.org/installation/do-it-yourself)**
- Heat Pump Water Heater Handbook from the American Council for an Energy Efficient Economy 2018 Summer Study on Buildings (**Widder and Larson**)
- AO Smith: **[aosmith.com](http://aosmith.com)**
- Bradford White: **[bradfordwhite.com](http://bradfordwhite.com)**
- Rheem: **[rheem.com](http://rheem.com)**
- Sanden: **[sandenwaterheater.com](http://sandenwaterheater.com)**

## **BetterBuilt<sup>NW</sup>**

As a market resource, BetterBuiltNW is committed to accelerating the adoption of the most energy-efficient building practices in residential new construction. BetterBuiltNW is a core component of the Northwest Energy Efficiency Alliance's (NEEA) Residential New Construction Program.

To learn more, visit **[betterbuiltinw.com](http://betterbuiltinw.com)**